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ABSTRACT

Studies of over 100 chess players at varying skill levels and ages show the ways in which experts and nonexperts differ in problem-solving strategies. Important differences are found at all stages of problem solving. The most significant differences appear to be before and after the evaluation of alternatives ("sizing up" the problem, generating alternatives, and evaluating outcomes). Insight into how expertise develops and how it can be fostered can be gained by following the development of young players with high potential. Discussion focuses on expertise, stages of problem solving, identification of experts and potential experts, and training. (RH)

WHERE EXPERTS COME FROM

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ABSTRACT

Studies of over 100 chess players at varying skill levels and ages show how experts and nonexperts differ in problem solving strategies. Important differences are found at all stages of problem solving, but the most significant differences appear to be before and after the evaluation of alternatives ("sizing up" the problem, generating alternatives, and evaluating outcomes). In addition, following the development of young players with high potential gives insight into how expertise develops and how it can be fostered.

EXPERTISE

A complex society needs experts, but very little is known about how expertise develops. My colleagues (Terry Morgan and David Morgan) and I are studying the development of chess expertise [1]. We have collected data from over one hundred chess players, some are experts, some are competent players, some are beginners, and some have the potential to become experts. Experts are characterized by their vast knowledge and by their fast, accurate, and intuitive judgments. One big question for psychologists is how to reconcile the two: If one has vast knowledge, wouldn't it take a long time to search through it to find the best solution to a difficult problem? Non-experts do need a lot of time to weigh all the data, but experts can give an intuitive answer that "feels" right. The expert medical diagnostician, for example, has educated guesses which he then carefully evaluates. He is able, before exhaustive search, to identify good possible solutions. The non-expert has to attempt the exhaustive search first. The non-expert rarely finishes the search; instead he will stop when a satisfactory solution is found. The expert typically identifies a small set of good alternatives, then chooses the best. The non-expert has to search harder to find the alternatives and he may miss some of the better ones. Experts make better decisions in less time.

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Chess is an ideal way to study decision-making and problem solving because it is a closed system with clearly defined rules. Unlike decisions in the real world, there are not a lot of extraneous variables that may affect the outcome of a decision. Because of the extreme complexity of chess, it pushes human information processors to their limits. By studying how expertise develops in chess, we can learn a great deal about expertise in general. Another advantage of chess as an object of study is the existence of an accurate skill measurement system. The Elo system, derived from probability theory, is used to rate all players in U.S. Chess Federation tournaments. Our sample of players' ratings range from 1100 (about 2 standard deviations below the mean) to master level (above 2200, about 3.5 standard deviations above the mean). Tournaments, of course, tend to attract fairly serious players, so an 1100 level player can beat most

casual, non-tournament players.

Much of the chess research (see Holding [2]) has focused on memory; our interests focus on the broader issues of how chess expertise develops. First we will describe in general terms the problem-solving process. Then we will discuss the players and how their expertise might have developed.

STAGE 1: SIZING UP THE PROBLEM

When faced with a problem, the first step is to analyze the problem in a preliminary and impressionistic way: "sizing up" the problem. The manner in which this is done will influence the types of solutions considered. This analysis involves looking for ways to characterize the problem. Is it LIKE others? Rarely will it be identical to previous problems, so the notion of SIMILARITY is crucial. A problem solver who sees similarities where others don't will have more options for a solution. The level of similarity (e.g., abstract or superficial) will influence the range of choices.

Let's look at this stage for a chess player. Say our player is examining the board for a good move. The first step--the preliminary analysis--will be at several levels simultaneously. The player will no doubt see a variety of ways in which the current situation is similar to others he has been in or games he has read. The pawn structure may be similar, the overall attack strategy may be similar, the type of opening played may be similar, the possible next move may be similar, the sacrifice to gain position, etc. These similarities "pop" out at the expert; the lesser player must search for them. The lesser player sees them as separate facts; the expert sees a PATTERN. This is one of the keys of the expert--the ability to see complex relations as wholes or gestalts. The expert can see the big picture. The key words are SIMILARITY and PATTERN. From these will come a global strategy for approaching the problem. The results of this stage will guide the rest of the process.

A more thorough analysis may or may not follow the preliminary analysis. This will be more analytic in nature. If the problem is similar to familiar ones, the person may have identified what cognitive psychologists call a "schema." This is an abstract representation of the typical events, scenes, etc. that are associated with the problem type. For example, we all have a schema about going to the dentist. It lacks detail and every dentist experience is somewhat different, but the cognitive representation is a fairly stable bundle of knowledge, expectations, beliefs, etc. In problem solving, we can talk about a problem "schema." After the preliminary analysis, the person may have several schemata that represent possible ways to think about the problem.

We've found that less developed plays skip this second analysis. These non-experts typically go from the preliminary, holistic analysis directly to the generation stage (discussed below), resulting in

overlooking crucial information. This suggests a satisficing kind of strategy--if the move that jumps out at the player is all right, he won't bother to look further. In chess, probably even more often than in life, satisficing leads to defeat.

STAGE 2: GENERATING ALTERNATIVES

After a more thorough analysis of the problem, the next step is to generate alternatives. This is a creative process that cannot be described with decision trees or utility matrices since these typically operate on specified alternatives. Very little is known about this stage of problem solving. We do know, in chess, that experts typically generate only a few alternatives. But they are also the BEST alternatives. Less-than-expert players typically generate the same number, and often more, alternatives. Many of these alternatives, however, are weaker than those generated by the expert.

The expert has good alternatives "pop" into his head while the lesser-player may have to systematically search the board for moves. The expert's "popping" phenomenon is analogous to what we all experience when we scan a list of names. Because of our extreme familiarity with our own name or those of our friends, they "pop" out. The expert player has a vast store of knowledge that can be easily accessed in a variety of ways. That is, the expert has acquired a vast number of interrelated schemata. The less experienced player may have a lot of facts, but he may not be able to retrieve that information. The similarity judgments select the relevent schemata which are rich sources of densely related information. The similarity judgments are JUDGMENTS and not the result of rational decision rules. Similarity judgments may involve a high level of abstract reasoning, or they may be based on very concrete similarities.

STAGE 3: EVALUATING ALTERNATIVES

Next, the problem-solver must evaluate the alternatives. This stage has been studied, and it is possible to describe rational processes for choosing among alternatives. If the problem solver rejects all the alternatives, he must go back to the previous stage and generate more (or, possibly return to the analysis stage and reanalyze the problem).

Chess players evaluate alternatives by "calculation." The player figures the tree of moves that could result from each of his candidate moves. Depending on his skill at this task, the calculation may go several to eight or ten moves ahead. This stage requires serious concentration and memory abilities. The expert can do it in his head with visual imagery. A lesser player (in a non-tournament situation) may want to actually move the pieces on the board. The expert often can bypass some of the calculation by identifying or labeling a series of moves as a standard series with which he is familiar. A player who knows many thousand "book moves" will have an advantage. The expert has a tremendous advantage over the lesser-player at this stage

because the previous stage resulted in good alternatives. It's easier to be successful if all your alternatives are good! In fact, in speed chess games, where each player is alloted two or three minutes for all his moves, it is very difficult to distinguish a chess master's speed game from his regular long game. That is, their play is almost as high quality whether the game took two minutes or eight hours! The time savings comes by eliminating the second step in the analysis stage and most of evaluation stage.

We've observed adults and children playing speed games and find that children seem to have an advantage under such conditions. Children, in their normal play, tend to minimize the second step in the analysis stage and most of the evaluation stage. The cognitive skills required to operate within those stages well are typically not well developed until Piaget's formal operations stage. We believe that players who learn the game during childhood will maintain strength in the first step of the analysis stage--sizing up the problem--while developing deeper or more abstract bases for judgments of similarity. During a player's development (chess and general development), he will naturally strengthen the other stages. Players who learn chess after childhood probably will remain weak in the sizing up stage unless explicit training is received. Krogius [3] reports that grandmasters who learned chess before their tenth birthday made fewer blunders in tournament play. He attributes this to the fact that chess is for the early learners a "native language." We believe this native language amounts to strong intuitive similarity judgments. Just as we can judge grammaticality by whether or not "it sounds right," players who have developed stage one early in life can sense ways in which game situations are similiar.

Children may also rely more heavily on heuristics and short cuts than do adults. These heuristics are ways of simplifying complex inputs. Children must constantly simplify input because their schemata are less well developed. Pushing these schemata to their limits and subjecting them to evaluation may speed up the process of developing more elaborate schemata. In Piagetian terms, assimilation and accomodation occur cyclically as schemata evolve. The rapid testing and retesting of schemata may accelerate development.

STAGE 4: EVALUATING THE OUTCOME

Evaluating the outcome of his solution will increase the level of expertise. This stage has been studied, although less than the evaluation of alternatives stage. Einhorn and Hogarth [4], for example, discuss the reason why humans have undeservedly high estimates of their own judgment abilities. Part of the reason is that we only evaluate the outcome of the chosen alternative. We do not ask whether any of the rejected alternatives might have been better. We propose, based on our chess research, that those people who become experts are better at objectively evaluating their decisions. But more importantly, they often replay games using rejected moves. This gives them information on "false negatives"--those alternatives that were falsely classified as no good. Experts and potential experts

want to know, even when they are successful, if there was a better alternative available to them. Non-experts, after a game, roll up their board and go home.

Einhorn and Hogarth also stress the importance of receiving feedback on the process of a decision as well as on the outcome of a decision. Experts and potential experts evaluate their strategy as well as the outcomes of particular moves. They also evaluate their computation and other details of their decision making processes. This multi-level feedback and evaluation is necessary for improvement. Experts and potential experts are often consumed with the need for self-evaluation and feedback. We believe this is a key to their success.

WHO ARE THE EXPERTS AND THE POTENTIAL EXPERTS?

Our potential experts are all active, popular children. All six of our youngest, most precocious players (ranked in the top ten in the country for their age) have other interests outside of chess ranging from soccer and basketball to music, poetry, and art. They are all intelligent and good students. All six can be characterized as well adjusted. They all come from well educated, upper middle class parents (no single parents) and all are male. We suspect that the environment for upper middle class males is more conducive to high levels of competition and achievement. Other environments can support this level (an inner city elementary school in Indianapolis won the national elementary school chess title several years ago), but males from upper middle class environments seem to have an advantage.

All six are extremely competitive and are driven to win. None of them wants a superior player to "go easy" on them. After losing to a superior player, they are more determined to continue. This seems to result from high levels of self confidence. Any of these players can lose ten times in a row to a superior player and keep going. They don't see themselves as "little kids" playing against adults. Being seven years old does not count as an excuse when they lose to a 30 year old. When asked why they lost a game, they will usually--accurately--blame themselves.

These characteristics are evident in non-chess behaviors. One child, at age four, had ridden the Gilley's mechanical bull of Urban Cowboy fame. He knew the correct posture: back straight, head up, and one hand in the air. He held that posture even though he was frightened and crying and would have liked to hold on with two hands. Parents of all these children tell similiar stories of early persistence. These children actively put themselves in highly stressful, highly competitive situations. They play in adult tournaments, even though they know they will lose most games.

Much has been written about the personality of chess masters (e.g., see Fine, [5]. Perhaps the most striking similarity is the intense devotion to chess and the vast amounts of time devoted to the game. Many expert players are also experts in other fields, most notably mathematics and the sciences. A few, like Bobby Fischer, excel only

in one domain, but most are able to maintain several areas of interest. The expert and the potential expert can be characterized as highly intelligent, passionate in their interest, and eager to evaluate their own work.

TRAINING

From talking to chess coaches and reading some of the literature on Russian methods of chess training, we have found techniques that may have broader applications. Paradoxically, players are trained both to play faster and to play slower. Children tend to play fast without much calculation, so coaches work on having them take more time with moves. In our studies, we found that longer analysis time was correlated with a deeper level of analysis. Coaches also stress speed training with children. In general, children approach the world in a whirlwind fashion, acquiring schemata rapidly (often inaccurately). Evidence from chess coaching suggests that practice in speed chess keeps alive rapid schema acquisition. With only a quick glance, the perspective has to be more of a gestalt.

Children, like experts, rely heavily on intuitive judgments. Speed chess is widely used as a training method because it forces one to rely on intuitions and to operate at a global level. Playing fast develops intuitions and a global perspective; playing slow develops the analytic thought processes and perspective. Experts need both.

If speed training is vital for developing expertise in chess, what implications does that have for developing expertise in other domains? Perhaps MBA students, too, rather than being discouraged from "shooting from the hip" should be given practice in making quick decisions. Like the young chess players, their moves may not be as high quality under speed conditions, but the process may force a different, more global, perspective on the problem. Math teachers have long used speed drills for math facts. Perhaps speed drills used for more complex problems could be useful for developing expertise.

Russian psychologists have found that grandmasters who learned chess very early in life make fewer errors in games and are able to stay at their chess playing peak for more years. This suggests, as does our research, that the child's natural inclination to operate at a "gut" level gives him an advantage in the preliminary analysis stage when faced with a complex task. Unfortunately, without special training, most of us learn to shorten, or even distrust, the preliminary stage in favor of the more analytic second stage of the analysis stage. A rich preliminary analysis stage may surface later as high levels of expertise develop. But that may be becoming an expert the hard way. Players who begin early in life may be able to maintain both both types of anaysis, increasing the likelihood that they will become experts.

Players can develop early skills through playing experience, but most players must soon attack the body of chess knowledge. As in all cases of expertise, a vast number of facts and theories must be mastered.

Without this, expertise cannot develop. Top players--even those six years old--do their homework. As Chase and Simon [6] say, there is no shortcut to becoming a master.

How likely one is to become an expert depends heavily on the environment. One needs to be exposed to players who are better. Many promising players do not become experts because they do not have access to role models or to other players.

Looking at how players progress through the ratings shows that the path to expertise is rot a straight line. At the early stages, those with motivation and potential progress rapidly, but when the player approaches the mean, the curve reaches a snag. Coaches say that that is the point where study becomes essential. Among adults, there appear to be relatively few active tournament players with ratings in that "low average" range. They tend to drop back, or they pursue excellence and go up. This appears to be a crucial (and predictable) stage in the development of chess expertise. We suspect that expertise in any domain has a similar hurdle. This hurdle may be characteristic of the fair-haired young man (or woman) who is rising fast, but hits a plateau. We see in our sample of chess players, that some lose interest, some get distraught, and a few buckle down and plunge ahead. Those who do plunge ahead need direct instruction, access to lots of information, peer stimulation, a role model or mentor, a chance to try out new strategies, high self esteem, and a great deal of encouragement. Expertise is more than hard work. It takes a special kind of person and a special kind of environment.

REFERENCES

[1] Morgan, D., Morgan, T.,& Morgan, D, "Levels of Processing in Chess Cognition." Forthcoming.

[2] Holding, D., The Psychology of Chess Skill (Hillsdale, NJ: Erlaum, 1985).

[3] Krogius, N., Psychology in Chess (translated K. Young & B. Cafferty, New York: RHM Press, 1976).

[4] Einhorn, & Hogarth, "Confidence in Judgment: Persistence of the Illusion of Validity." Psych Review, 85, (1978), pp. 395-416.

[5] Fine, Reubin, The Psychology of the Chess Player (New York:Dover, 1967).

[6] Chase, W.G. & Simon, H.A., "Perception in Chess." Cognitive Psychology, 4, (1973) pp. 55-81.